From . Nabil Dbaibo

INCLUDE MAIL STOPS

To . Kenny Ezeokeke

NW NB82-143

ECON-O-GRAM

"To Provide Faster Service at Lower Cost"

Subject FILE # 0L-2305

SR-167 Stage 3
15th St. SW to 15th St NW
Wall design Summary

☐ PLEASE REPLY BY:

☑ NO REPLY REQUIRED

Message

Attached are the design parameters for Walls # 1, 2, 4, 5, 6 & 8. All these wall are MSE walls.

In the March 24, 98 Geotech report, walls 1, 2 & 5 were incorrectly called Standard Concrete walls - These walls are MSE walls.

Underdrain pipes are not needed with MSE walls, because the fill material used to construct them should be gravel borrow per Standard Spec. 9-03.14(1).

The design parameters for wall 8 by Shannon & Wilson were reviewed and are summarized & tabulated (see attachment).

SIGNATURE [signature] PHONE NO. ( ) 5469 DATE 8/18/98

Reply

SIGNATURE PHONE NO. ( ) DATE

FORM S.F. 1(2/97)

The following design parameters should be included in the Special Provisions for the wall designs along SR-167, 15th Street SW to 15th Street NW, HOV Lanes Stage 3, MP 13.73 to MP 15.76:

WALL 1

Soil Properties	Wall Backfill	Retained Soil	Foundation Soil
Unit Weight, kN/m³ (pcf)	19.6 (125)	18.5 (125)	18.8 (120)
Friction Angle, deg.	35	35	28
Cohesion, kN/m² (psf)	0	0	0

AASHTO Load Group	I	VII
Allowable Bearing Capacity, kN/m² (tsf)	96 (1.0)	125 (1.3)
Seismic Coefficient (g)	N/A	0.27

WALL 2

Soil Properties	Wall Backfill	Retained Soil	Foundation Soil
Unit Weight, kN/m³ (pcf)	19.6 (125)	19.6 (125)	18.8 (120)
Friction Angle, deg.	35	35	28
Cohesion, kN/m² (psf)	0	0	0

AASHTO Load Group	I	VII
Allowable Bearing Capacity, kN/m² (tsf)	140 (1.5)	190 (2.0)
Seismic Coefficient (g)	N/A	0.27

WALL 4

Soil Properties	Wall Backfill	Retained Soil	Foundation Soil
Unit Weight, kN/m³ (pcf)	19.6 (125)	19.6 (125)	20.4 (130)
Friction Angle, deg.	35	35	36
Cohesion, kN/m² (psf)	0	0	0

AASHTO Load Group	I	VII
Allowable Bearing Capacity, kN/m² (tsf)	240 (2.5)	310 (3.25)
Seismic Coefficient (g)	N/A	0.27

WALL 5

Soil Properties	Wall Backfill	Retained Soil	Foundation Soil
Unit Weight, kN/m³ (pcf)	19.6 (125)	19.6 (125)	20.4 (130)
Friction Angle, deg.	35	35	36
Cohesion, kN/m² (psf)	0	0	0

AASHTO Load Group	I	VII
Allowable Bearing Capacity, kN/m² (tsf)	290 (3)	375 (4)
Seismic Coefficient (g)	N/A	0.27

WALL 6

Soil Properties	Wall Backfill	Retained Soil	Foundation Soil
Unit Weight, kN/m³ (pcf)	19.6 (125)	19.6 (125)	20.4 (130)
Friction Angle, deg.	35	35	36
Cohesion, kN/m² (psf)	0	0	0

AASHTO Load Group	I	VII
Allowable Bearing Capacity, kN/m² (tsf)	240 (2.5)	310 (3.25)
Seismic Coefficient (g)	N/A	0.27

WALL 8

Soil Properties	Wall Backfill	Retained Soil	Foundation Soil
Unit Weight, kN/m³ (pcf)	19.6 (125)	19.6 (125)	18.8 (120)
Friction Angle, deg.	34	34	27
Cohesion, kN/m² (psf)	0	0	0

AASHTO Load Group	I	VII
Allowable Bearing Capacity, kN/m² (tsf)	145 (1.5)	190 (2.0)
Seismic Coefficient (g)	N/A	0.27

WALL 9

Soil Properties	Wall Backfill	Retained Soil	Foundation Soil
Unit Weight, kN/m³ (pcf)	19.6 (125)	18.5 (117)	18 (115)
Friction Angle (deg.)	38	34	34
Cohesion, kN/m² (psf)	0	0	0

AASHTO Load Group	I	VII
Allowable Bearing Capacity (kN/m²)	190 (2.0)	290 (3.0)
Seismic Coefficient (g)	N/A	0.27

Design Notes:

1. The wall shall be placed on a level foundation in the horizontal direction perpendicular to the wall face.
2. The base width of the wall should be at least 70 percent of the wall height. Wider wall base might be needed to provide adequate internal stability.
3. The uppermost reinforcing layer must be placed no lower than 0.6 m (2 ft) below the top of the wall.
4. Wall base embedment should be at least 0.6 m (2 ft) below final finished grade.

5. For wall on sloping ground minimum embedment shall be per WSDOT Bridge Design Manual for footings on slopes
6. In areas where soft subgrade is encountered, it should be over-excavated to a minimum depth of 0.3 m (2 ft), or as directed by the engineer, and replaced with compacted gravel borrow

WALL # 1
Stage 3

Washington State Department of Transportation

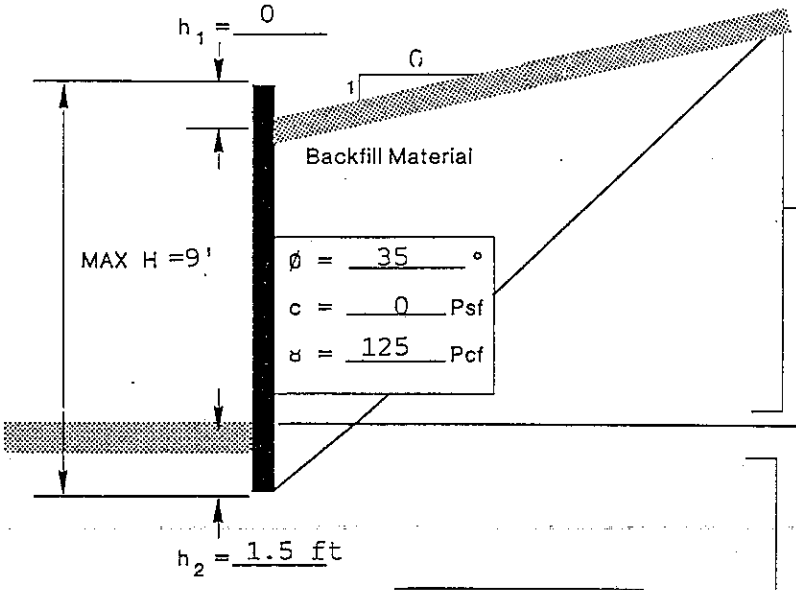
RETAINING WALL DATA SHEET

WALL 1

Dist. No. 1 Control Section 1766 SR No. 167 Job No. L-1511 Date 1/4/94

Project Main St to 84th Ave South Prepared By DGC

Wall Type Planned MSE



Show Location of Water Table: ▽ Elev-35 ft

Fill Material or Native Soil = Fill - gravel borrow

ø = 35 °
c = 0 Psf
ϑ = 125 Pcf

Foundation Soil Soft silt and loose to medium dense silty SAND. See Remark 2.

Allowable Bearing Value: 1.0 Tsf

Recommended Footing Elev. See Remark 1

Pile Support: Yes ____ No X

Pile Type: ____

ADDITIONAL SKETCHES REQUIRED:

1. Profile of Complete Retaining Wall
2. Sketch showing location of sewer lines, water mains, etc,
3. Sketch showing type and location of all surcharges (buildings, bridge footings, streets, etc.) located above the proposed footing elevation of the wall within a horizontal distance equal to three times the wall height.
4. Sketch showing all planned drainage (applies to drainage behind wall) and how seepage and runoff are to be handled. Mention if areas of heavy seepage are anticipated.

REMARKS—

1. Minimum embedment = 1.5 ft.
2. The soft silts beneath the wall from W1 Station 12+50 to 15+50 may be overexcavated 3 ft below the base of the wall and backfilled with good quality granular material compacted to 95% maximum density to reduce settlement.
3. 24 inch diameter concret pipe at Wall Station 13+45.

Wall #2
Stage 3

Washington State Department of Transportation

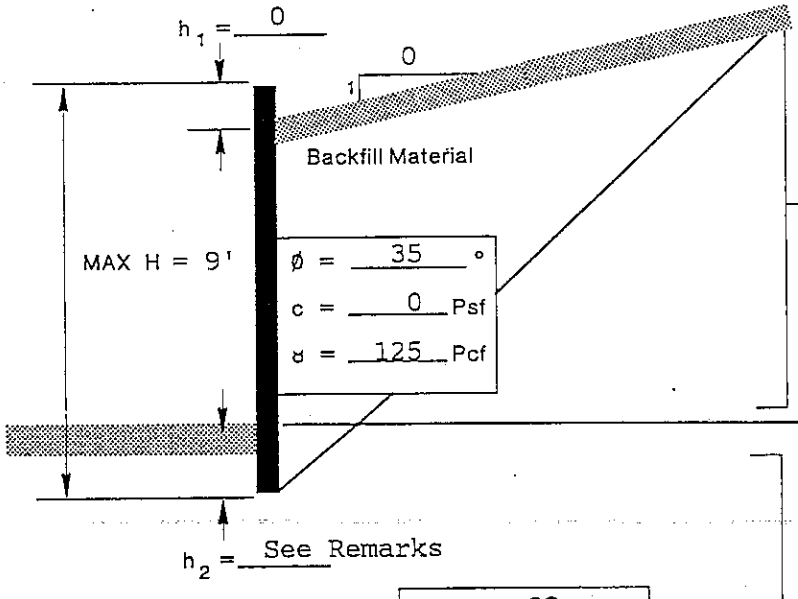
RETAINING WALL DATA SHEET

WALL 2

Dist. No. 1 Control Section 1766 SR No. 167 Job No. L-1511 Date 1/4/93

Project Main St to 84th Ave South Prepared By DGC

Wall Type Planned MSE



Show Location of Water Table: ▽ Elev = 34 ft

Fill Material or Native Soil = Fill gravel borrow

ø = 35 °
c = 0 Psf
ɣ = 125 Pcf

Foundation Soil Medium dense silty SAND and stiff sandy SILT.

Allowable Bearing Value: 1.5 Tsf

Recommended Footing Elev. See Remark No. 1

Pile Support: Yes _____ No X

Pile Type: _____

ADDITIONAL SKETCHES REQUIRED:

1. Profile of Complete Retaining Wall
2. Sketch showing location of sewer lines, water mains, etc,
3. Sketch showing type and location of all surcharges (buildings, bridge footings, streets, etc.) located above the proposed footing elevation of the wall within a horizontal distance equal to three times the wall height.
4. Sketch showing all planned drainage (applies to drainage behind wall) and how seepage and runoff are to be handled. Mention if areas of heavy seepage are anticipated.

REMARKS—

1. Minimum embedment = 1.5 ft.

Wall # 4
Stage 3

Washington State Department of Transportation

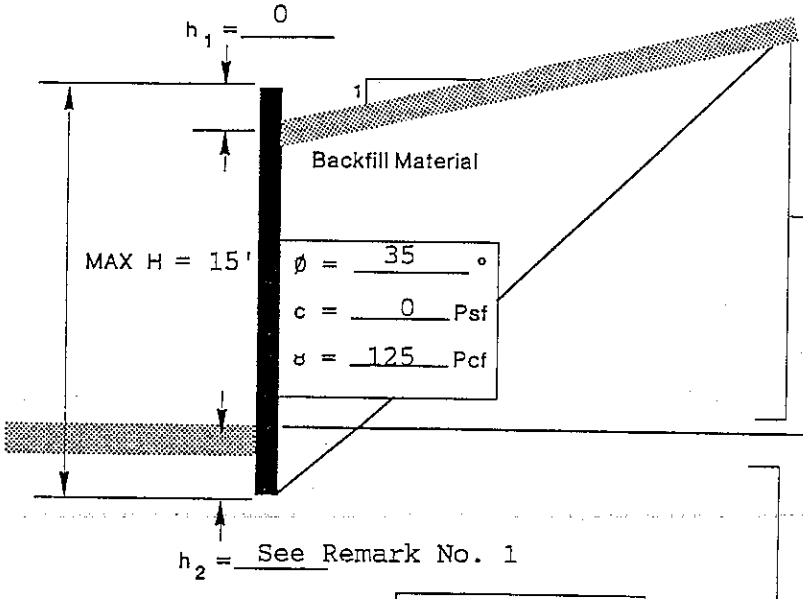
RETAINING WALL DATA SHEET

WALL 3

Dist. No. 1 Control Section 1766 SR No. 167 Job No. L-1551 Date 1/4/94

Project Main St to 84th Ave South Prepared By DGC

Wall Type Planned MSE



Show Location of Water Table: Elev = 31 ft

Fill Material or Native Soil = Fill - Gravel Borrow

ø = 35 °
c = 0 Psf
ϑ = 125 Pcf

Foundation Soil Embedment material - very dense sandy GRAVEL.

Allowable Bearing Value: 2.5 Tsf

Recommended Footing Elev. See Remark No. 1

Pile Support: Yes ____ No X

Pile Type: ____

ADDITIONAL SKETCHES REQUIRED:

1. Profile of Complete Retaining Wall
2. Sketch showing location of sewer lines, water mains, etc,
3. Sketch showing type and location of all surcharges (buildings, bridge footings, streets, etc.) located above the proposed footing elevation of the wall within a horizontal distance equal to three times the wall height.
4. Sketch showing all planned drainage (applies to drainage behind wall) and how seepage and runoff are to be handled. Mention if areas of heavy seepage are anticipated.

REMARKS—

1. Use minimum embedment criteria in the WSDOT Bridge Design Manual for footings on slopes for MSE wall or 0.3H for standard wall.
2. The minimum wall base width should be 0.6H.

Wall #5
Stage 3

Washington State Department of Transportation

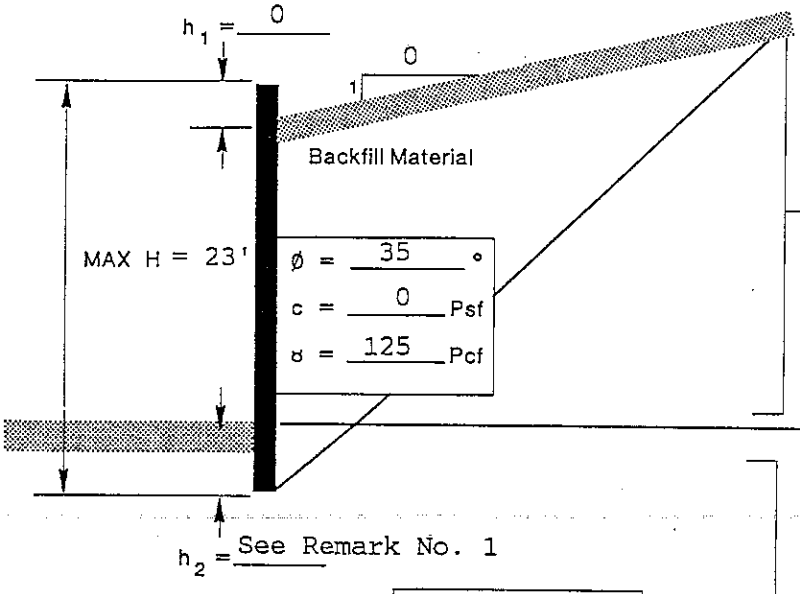
RETAINING WALL DATA SHEET

WALL 5

Dist. No. 1 Control Section 1766 SR No. 167 Job No. L-1551 Date 1/4/94

Project Main St to 84th Ave South Prepared By DGC

Wall Type Planned MSE



Backfill Material: ø = 35 °, c = 0 Psf, ɣ = 125 Pcf

Show Location of Water Table: ▽ Elev = 28 ft

Fill Material or Native Soil = Gravel Borrow

Fill Material: ø = 35 °, c = 0 Psf, ɣ = 125 Pcf

Foundation Soil Embankment Material
Very dense sandy GRAVEL

Foundation Soil: ø = 36 °, c = 0 Psf, ɣ = 130 Pcf

Allowable Bearing Value: 3.0 Tsf

Recommended Footing Elev. See Remark No. 1

Pile Support: Yes ____ No X

Pile Type: ____

ADDITIONAL SKETCHES REQUIRED:

1. Profile of Complete Retaining Wall
2. Sketch showing location of sewer lines, water mains, etc,
3. Sketch showing type and location of all surcharges (buildings, bridge footings, streets, etc.) located above the proposed footing elevation of the wall within a horizontal distance equal to three times the wall height.
4. Sketch showing all planned drainage (applies to drainage behind wall) and how seepage and runoff are to be handled. Mention if areas of heavy seepage are anticipated.

REMARKS—

1. Minimum embedment according to WSDOT Bridge Design Manual but not less than 0.25H.
2. The minimum wall base width should be 0.65H.
3. The wall will be constructed over two 48" CMP in the vicinity of Station 885+00.

Wall #6
Stage 3

Washington State Department of Transportation

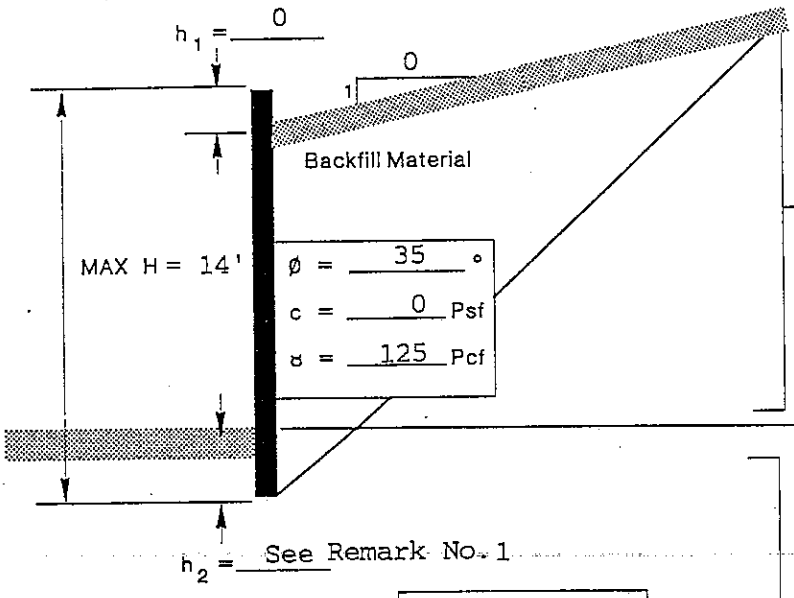
RETAINING WALL DATA SHEET

WALL 10

Dist. No. 1 Control Section 1766 SR No. 167 Job No. L-1511 Date 1/4/94

Project Main St to 84th Ave South Prepared By DGC

Wall Type Planned MSE



Backfill Material:
ø = 35 °
c = 0 Psf
ɣ = 125 Pcf

Show Location of Water Table: ▽ Elev = 35ft

Fill Material or Native Soil = Fill - Gravel

ø = 35 °
c = 0 Psf
ɣ = 125 Pcf

Foundation Soil Embankment material - Very dense sandy GRAVEL.

ø = 36 °
c = 0 Psf
ɣ = 130 Pcf

Allowable Bearing Value: 2.5 Tsf

Recommended Footing Elev. See Remark No. 1

Pile Support: Yes ____ No X

Pile Type: ____

ADDITIONAL SKETCHES REQUIRED:

1. Profile of Complete Retaining Wall
2. Sketch showing location of sewer lines, water mains, etc,
3. Sketch showing type and location of all surcharges (buildings, bridge footings, streets, etc.) located above the proposed footing elevation of the wall within a horizontal distance equal to three times the wall height.
4. Sketch showing all planned drainage (applies to drainage behind wall) and how seepage and runoff are to be handled. Mention if areas of heavy seepage are anticipated.

REMARKS—

1. Minimum embedment according to WSDOT Bridge Design Manual but not less than 0.2 H for MSE walls or 0.3 H for standard wall.
2. The minimum wall base width should be 0.65 H for MSE walls.

mended from Sta. 1075+60 to Sta. 1076+50 and Sta. 1081+00 to Sta. 1083+50 because fill heights are relatively low. The surcharge fill should occupy the width of the HOV lane widening. We estimate settlements would take place in 15 to 30 days and should be monitored with a series of settlements plates. Measurements should be taken weekly. Plates should be embedded near the base of the wall and spaced at 100-foot intervals. This settlement estimate should only be used for preliminary planning purposes. The removal of the surcharge load, however, should be based on the field data from the settlement plate readings. This may require adjustments within the construction schedule to accommodate potentially longer preload requirements.

C. We recommend an allowable bearing pressure of 3,000 pounds per square foot (psf) for the wall design. This pressure may be increased by 1/3 for transient loading. A friction coefficient of 0.5, which includes a factor of safety of 1.5, should be used to calculate sliding resistance. Lateral fluid densities of 30 pcf and 42 pcf are recommended for permanent and short-term surcharge loading conditions, respectively. These pressures reflect a level ground surface behind the wall. A minimum traffic surcharge of 2 feet is recommended. In other words, the lateral pressure with surcharge for a 6-foot wall should be based on a total height of 8 feet. Alteratively, the retained backfill and the fill soil at the base of the wall may be characterized by a unit weight of 125 pcf and an internal friction angle of 34 degrees with an appropriate pressure increase for traffic surcharge.

D. Since native loose sand may be present below the Gabion wall, there is a potential that these soils may liquify during a strong earthquake. Liquefaction of these sediments may result in several inches of settlement of the wall.

4.3 Wall 8

4.3.1 Subsurface Conditions

Subsurface conditions in the vicinity of Wall 8 were evaluated from three borings drilled specifically for this study and from the results of other explorations advanced for the SR 167 mainline roadway and associated facilities. The locations of these explorations are shown on Figure 12. Individual logs of these explorations are presented in Appendix A. Generalized subsurface conditions along Wall 8 are provided in Figures 13 through 16.

Subsurface conditions along Wall 8, as depicted in Figure 16, indicate that the wall alignment may be underlain by a surficial stratum of fill soils that may have been placed in conjunction with the construction of the adjacent frontage road and associated utilities. These

fill soils overlie a layer of loose silty sand to soft clayey, peaty silt which extends to an elevation of approximately 5 feet. Below these compressible soils, medium dense sands were encountered in the site explorations which typically terminated between elevations 0 and -10 feet.

The fill soils encountered in the explorations may not necessarily underlie the proposed location of Wall 8, considering that the explorations may have been advanced through fill of the adjacent frontage road. Therefore, the surficial soils at the location of Wall 8 may consist of soft compressible sediments that extend to about elevation 5 feet. These compressible sediments may be 15 to 20 feet thick at the location of Wall 8.

The groundwater level was typically observed in the site explorations within about 5 feet of the existing ground surface. However, groundwater was encountered at a depth of 14 feet at boring location B 8-2.

4.3.2 Design Recommendations

Since Wall 8 will be constructed over compressible sediments or loose soils, it is recommended that a flexible wall system be used to provide restraint to the embankment fill. This wall system would be required to provide a grade separation ranging from 3 to 12 feet. The most economical means of providing this support, in our opinion, would be through the construction of a Gabion wall. However, other wall types may be similarly considered as alternatives for this location. Other wall types could include a Hilfiker (welded wire) wall system, a VSL/Reinforced Earth wall, criblock wall, a Gravity Stone/Keystone wall, and geogrid/geotextile walls. With the exception of Gravity Stone/Keystone walls and geogrid/geotextile walls, all of the above wall types have been pre-approved by WSDOT. In our opinion, a conventional concrete cantilever wall is not recommended at this location because of the underlying compressible soils. Use of a concrete cantilever wall would necessarily require installation of piling to provide support for the wall. Alternatively, open fill slopes inclined at 2(H):1(V) may be used for embankment construction provided that this fill remains within the WSDOT right-of-way. This alternative would particularly apply north of Station 980+00.

The following provides specific recommendations for construction of a flexible well system (i.e., gabion wall) at the location of Wall 8:

A. To provide a suitable foundation for the wall and reduce potential settlements, the soils to a depth of 4 feet below the base of wall should be removed and replaced with GBF. This overexcavation would apply over the entire length of the wall. The overexcavation should extend 15 feet behind the face of the wall.

Excavation of soft organic soils could be accomplished in the wet with a backhoe and the excavation should be immediately backfilled with GBF. This procedure, if accomplished properly, would avoid the need for shoring. In our opinion, the backfill may be end dumped without compacting for portions of the fill located below the water table. Above the water table, the fill should be compacted to 95 percent of maximum density (WSDOT Standard Specification 2-03.3(14)C, Method C).

Stability analyses of the wall with the recommended foundation overexcavation indicated that the proposed design would have a minimum factor of safety of 1.5.

B. The extent of compressible soft organic soils are more prevalent at Wall 8 compared to Wall 7. Consequently, larger settlements are anticipated and the time to the end of primary consolidation would be longer. The potential also exists for settlement of the adjacent East Valley Road.

Settlements at Wall 8 are estimated to range from 4 to 8 inches. To accelerate these settlements, we recommend placing a 4-foot surcharge over the full width of the HOV lane widening. Settlements from this surcharge are estimated to occur in 30 to 60 days and should be monitored with a series of settlement plates embedded at the base of the wall. The plates should be spaced at 100-foot intervals and readings obtained on a weekly basis. This settlement estimate should only be used for preliminary planning purposes. The removal of the surcharge load, however, should be based on the field data from the settlement plate readings. This may require adjustments within the construction schedule to accommodate potentially longer preload requirements.

C. We recommend an allowable bearing pressure of 3,000 pounds per square foot (psf) for the wall design. This pressure may be increased by 1/3 for transient loading. A friction coefficient of 0.5, which includes a factor of safety of 1.5, should be used to calculate sliding resistance. Lateral fluid densities of 30 pcf and 42 pcf are recommended for permanent and short-term surcharge loading conditions, respectively. These pressures reflect a level ground surface behind the wall. The equivalent fluid weight should be increased to 45 pcf to reflect a 2(H):1(V) permanent slope behind the wall. A minimum traffic surcharge of 2 feet is recommended. In other words, the lateral pressure with surcharge for a 6-foot wall should be based on a total height of 8 feet. Alteratively, the retained backfill and the fill soil at the base of the wall may be characterized by a unit weight of 125 pcf and an internal friction angle of 34 degrees with an appropriate pressure increase for traffic surcharge.